REMARKS

This paper is reponsive to an Official Action that issued in this case on July 25, 2007. In that Action, the Office:

- Rejected claims 1 and 3 35 USC §112, ¶2.
- Rejected claims 1-9, 11, 12 and 212-28 under 35 USC §103 as being obvious over U.S. Pat. No. 4,391,036 to Kishimoto in view of U.S. Pat. No. 4,317,872 to Varma in view of.
- Rejected claim 10 under 35 USC §103 as being obvious over Kishimoto, Varma, and further in view of U.S. Published Pat. Appl. No. 2005/0042512 to Ferreira.

In response to the Action, applicants have amended claim 1 and canceled claim 3. Reconsideration is respectfully requested in view of the foregoing amendments and the following comments.

Rejection of Claims 1 and 3 under 35 USC §112, ¶2

Claim 1 was rejected as being indefinite because, according the Office, "the acronym AGM does not particularly point out what kind of separator is being claimed." Applicant had resisted making this amendment because, to one skilled in the art, the acronym "AGM" does indeed specify the type of separator is being claimed. But since the Examiner is insistent that the acronym should not be used, applicant has now amended the claim.

The Office rejected claim 3 because, allegedly, "it is unclear … what the desired value of the specific gravity is." Furthermore, according to the Office "[i]t is also unclear how the specific gravity is a function of the voltage."

As previously explained, the desired value of the specific gravity is a function of the desired voltage of the battery. If a manufacturer wishes to make a 12 volt battery, the desired value will be one number, and if the manufacturer wishes to make a 9 volt battery, the desired value of the specific gravity will be another number. And to determine what this desired value will be, the manufacturer uses the well known "Nernst" equation to calculate the required concentration of sulfuric acid. With some simplification, the equation reduces to:

$E = E^0 + [2 \times 2.303\ RT/\ (nF)] \times [\log a_{H2SO4}]$

Where: E is the cell voltage;
E^0 is the standard electrochemical cell potential;
R is the gas constant (8.314 J/deg-mole);
T is the absolute temperature;
n is the number of moles of electrons involved in the oxidation-reduction reactions (2, in this case);
F is the Faraday constant (96,485 C/mole);
a is the activity (*i.e.*, effective concentration) of reactants and products;

The activity of sulfuric acid is related to the actual electrolyte concentration by the expresssion:

$a_{H2SO4} = 4 \times \gamma_m^3 \times C^3$

Where: C is the molal concentration (molality);
γ_m is the mean activity coefficient. The activity coefficient is generally temperature and concentration dependent and is experimentally determined and is known to manufacturers and generally available. (*See*, *e.g.*, Staples, Bert R., "Activity and osmotic coefficients of aqueous sulfuric acid at 298.15K," JPhysChemRefData, V10, no. 3, Jul 1981, pp 779-798.)

As a consequence, the manufacturer selects the desired voltage for the battery, such as 12 volts, and then directly calculates the required electrolyte concentration (concentration of sulfuric acid) from the Nerst equation. As is known to those skilled in the art, and as disclosed in applicant's specification at [0046], electrolyte strength is generally characterized by specific gravity. Tables that give specific gravity as a function of electrolyte concentration are readily available.

This should clarify for the Examiner how the specific gravity (of the electrolyte) is a function of the voltage (of the battery).

It is believed that the amendment to claim 1 and the foregoing explanation with regard to claim 3 overcomes the Section 112 rejections of these claims.

Claims 1-12 and 21-28 are
Allowable over the Cited Art

Kishimoto discloses a process for producing a sealed lead-acid battery, which includes an AGM separator. Kishimoto uses a tank formation process, not a jar formation process, to form the plates.

The Examiner believes that Kishimoto *et al*. teach a jar formation process. The Examiner alleged that:

> Applicants have explained that, in a tank formation process, the separator and the electrolyte are formed separately from the plates and then assembled, while in a jar formation process, the separator and electrolyte are formed with the plates.

The Examiner's words suggest a possibility of some misundertanding. Just to be clear, in lead-acid battery technology, "forming", "formation" and variants of these words denote the process of converting lead oxide to lead at the negative plate and converting lead to lead dioxide at the positive plate of a lead-acid battery precursor to which electrolyte is added to produce the lead-acid battery.

There are two important points here. One is that "formation" has nothing to do with the separator and electrolyte. The only thing that is "formed" are the plates. And that is true whether the plates are formed via jar formation or tank formation.

The second important point is that even if the plates are tank formed, once the plates are added to the actual battery container, electrolyte must still be added. In other words, the formed plates are the "lead-acid battery precursor." Electrolyte is added to the precursor to form the lead-acid battery.

The Examiner apparently mistook Kishimoto's disclosure in the Abstract that "a plate group … is inserted into a container. Then a sulfuric acid electrolyte … is first poured" as an indication that the Kishimoto is using jar formation. A battery-technology consultant working for the assignee of the present case has reviewed the Kishimoto reference and has assured applicant's attorney that Kishimoto uses tank formation. A declaration to that effect can be provided if necessary.

Aside from any other more technical reasons that indicate that Kishimoto uses tank formation, it is noted that none of the three "Experiments" disclosed by Kishimoto mention anything about the formation process, which would involve an initial charging step that takes place over several days. The absence of any such disclosure in the context of a discussion of experimental procedure is indicative of the fact that the plates were tank formed and then added to the container.

The Examiner notes that "it is known in the art to form the gel after the electrolyte is poured." This greatly oversimplifies the problem.

The difficulty with simply adding an electrolyte/silica mix that has a high-enough concentration of silica to gel is that it gels exceedingly rapidly – almost as quickly as it is mixed. The concern is that the electrolyte might not be absorbed by the pores of the plates before the mixture gels. Once the mixture gels, only limited absorption takes place. So it becomes a problem of timing.

Kishimoto addresses this by using two pours. The first is a pour that has a restricted amount (0 to 3%) of "viscosity-increasing agent" (*e.g.*, silica, *etc.*). This insures that the electrolyte in the center of the plate group has a low viscosity. (Col. 7, lines 7-12.) This ensures that the requisite absorption of electrolyte occurs.

After the first pour, a second pour with an electrolyte having a greater amount of silica, *etc.*, occurs, such that the electrolyte is allowed to gel near the periphery of the plate group. (Col. 7, lines 13-27.)

Alternatively, Kishimoto notes that the viscosity-increasing agent could be arranged in the peripheral part of the plate group to cause the electrolyte to gel in that region, and then add simply add sulfuric acid electrolyte (presumably without the viscosity-increasing agent. (Col. 9, lines 27-30.)

Ferreira also prevents gel formation in the pores of the plates, but he does so in a different manner. In particular, the Ferreira approach is to filter out the silica to prevent it from getting to the plates.

Ferreira discloses a lead acid battery having a gelled electrolyte that is formed by filtration action of an absorbent separator. Ferreira introduces an electrolyte-silica mix into a jar with unformed plates and a separator. The silica is a "never dried precipitated silica slurry." Mean particle diameter is said to be in the range of about 2 to 20 microns for "milled" versions of the silica and in the range of about 10 to 25 microns for "unmilled" versions. (Pg. 2, para. [0019].) The separator and/or the case into which the cells are inserted are specially formed to provide free space between the case and the edges of the plates and the edges of the separator material.

Ferreira discloses that "sulfuric acid is absorbed into the plates and the absorbent, porous filtration medium of the separator material while silica is filtered out of that sulfuric acid." (Page 2, para. [0023].) This enables Ferreira to provide a battery with a "novel electrolyte, some of which is immobilized as a **liquid** in the active material and the separator of the battery and the rest of which is immobilized because it is **gelled in free spaces** between the separator and the positive plate or plates of the battery." (Page. 3, para. [0042], emphasis added.)

The teaching of these references is not to gel the electrolyte in the pores of the plates. The method disclosed by applicants does cause electrolyte to gel in the pores of the plates.

Applicant addresses the problem of the premature gelling by adding an electrolyte mix that has a concentration of silica that will not gel in the absence of a change in concentration of the mix. Since the specific gravity is low enough, the mix readily flows and is absorbed into the pores of the AGM separator and the plates. Since colloidal silica is used, it is small enough to be absorbed by those pores.

Then the plates are formed *in-situ* (*i.e.*, jar formation). During the formation process, sulfate and water are driven off the plates, causing the specific gravity of the mixture to rise. This causes the mixture gels. It gels *everywhere*, in the open spaces, in the AGM separator, and in the plates.

It is true that one skilled in the art knew about colloidal silica (Varma), knew about jar formation and tank formation, knew about utilizing the formation process to cause gelling (Ferreira), *etc*. But that doesn't obviate applicants' claimed invention.

The fact is, fairly read, the references do not disclose or otherwise suggest contacting unformed plates with a silica/electrolyte mix, wherein the silica particles are small enough to be absorbed by the pores of the plates, and then forming the plates to gel the electrolyte.

This method is claimed, in varying language, in each of independent claims 1, 6, 21, and 25.

Conclusion

It is believed that claims 1-12 and 21-28 now presented for examination are allowable over the art of record. A notice to the effect is therefore solicited.

Respectfully,

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